Construction of a Chemical Sensor/Instrumentation Package Using Fiber Optic and Miniaturization Technology

Project Number: 97-12

Investigator: R.L. Newton/EH42

Purpose

The objective of this research is to design, construct and evaluate a sensor instrument package using fiber optic and miniaturization technology.

Background

NASA has recently refocused its efforts to provide low-cost access to space. The stated goal of reducing the cost of placing payloads in orbit by a factor of 10 requires advanced materials and technologies. Fiber optic and miniaturization technology, both rapidly advancing fields, fit well with our Agency's goals. The fiber optic industry has for some time been experiencing tremendous growth. This growth has been driven by the communications industry. This has resulted in making optical fiber a low-cost, high-durability product. As a spinoff, the use of optical fiber itself as a "sensing" device has now become common. Optical fibers are lightweight, immune to E–M radiation, and have low loss transmission properties.

The miniaturization of electronics and optical systems are realizing never before seen opportunities in real-time monitoring of gases, liquids, and even solid materials. Many of these new devices are called MicroElectroMechancial Systems (MEMS) devices. Most of the optical devices used in this research were fabricated using MEMS technology. The coupling of optical fibers with miniaturized optical systems can result in spectroscopy-based instrument packages that occupy much less than 50 percent of volume and/or weight of conventional monitoring systems. By integrating the control and data transmission of these instruments into the internet and wireless RF technologies, truly remote sensing and monitoring can be achieved. These technologies are maturing and will enable NASA to realize significant cost/weight savings on future spacecraft. New "sensing" technologies, both invasive and noninvasive, will find widespread technology transfer to industry in areas such as chemical, biological, medical and environmental. This study will allow MSFC to build on these growing technology bases and to incorporate these technologies into current and future NASA activities.

Approach

The instrument packages for this study will be designed, constructed and evaluated to verify the applicability of these technologies to MSFC/NASA real-world needs. Current laboratory instrumentation will be used to verify the performance of the constructed systems. The objective of this research is the detection of gases, heavy metals, or contamination on alloy surfaces using fiber-optic-based sensors. The limitation and sensitivity of the miniature equipment will be compared to known quantities of analyte in a laboratory environment. After baselining the equipment, real-life applications here at Marshall will be sought. Possible applications could be the monitoring of effluent pH from the plating facility, the volatile organic content from a monitoring well, or the real-time analysis of a rocket engine plume.

Accomplishments

Specific accomplishments include:

- Final design of sensor subsystems, procurement of data analysis/telemetry software;
- Procured all but one sensor (detector) system (expect delivery within three weeks);
- Constructed one of the designed configurations and collected data using wireless RF link (fig. 20); and
- Contract to provide assistance on software and hardware integration was initiated but was not executed. This has delayed some of the instrument construction and testing.

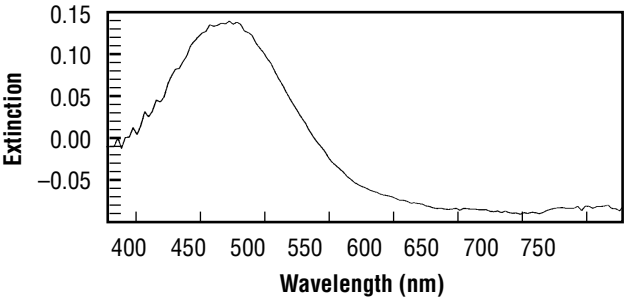

FIGURE 20.—300 ppm Iodine measured using MEMS-based spectrometer and wireless data link.

Planned Future Work

- Should receive final sensor subsystem within 30 days.
- Will begin full-time study in January 1998; request suspension of project until return to work.

Funding Summary ($k)

	FY97	FY98
Authorized:	70	10
Processed:	53	
Obligated:	53	
Balance:	27	

Status of Investigation

This project was approved in February 1997. Due to full-time study, the project completion date is October 1999.